



NOAA/NASA

# Annual Global Analysis for 2021

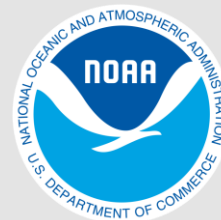
**Gavin A. Schmidt**

*Director, NASA Goddard Institute  
for Space Studies*



**Russell S. Vose**

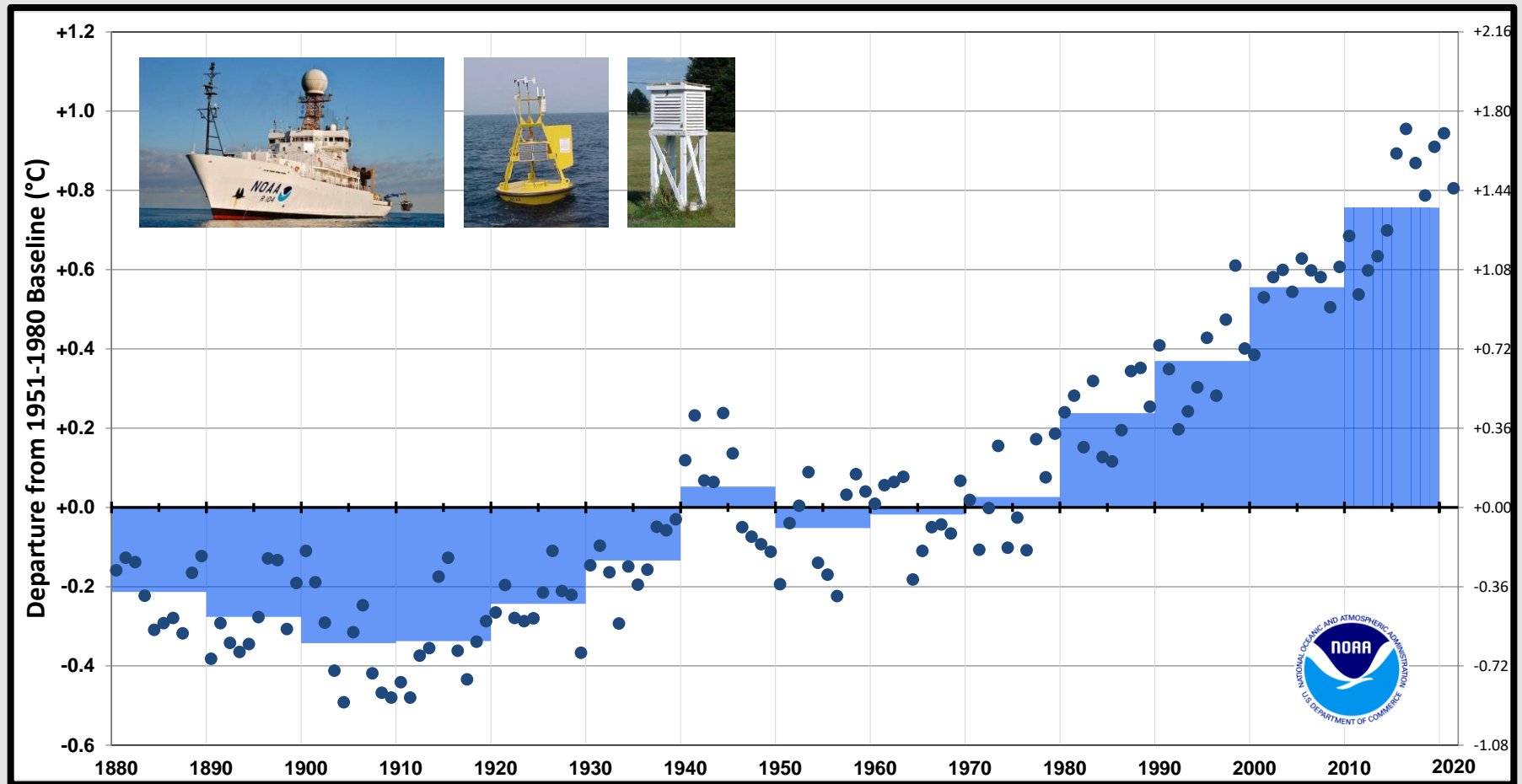
*Chief, Analysis and Synthesis Branch, NOAA's  
National Centers for Environmental Information*



January 2021

# NOAA: 2021 Ranked 6<sup>th</sup> Warmest

0.84°C (1.51°F) above 1901-2000 baseline\*, slightly warmer than 2021

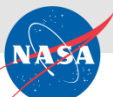
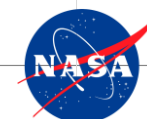
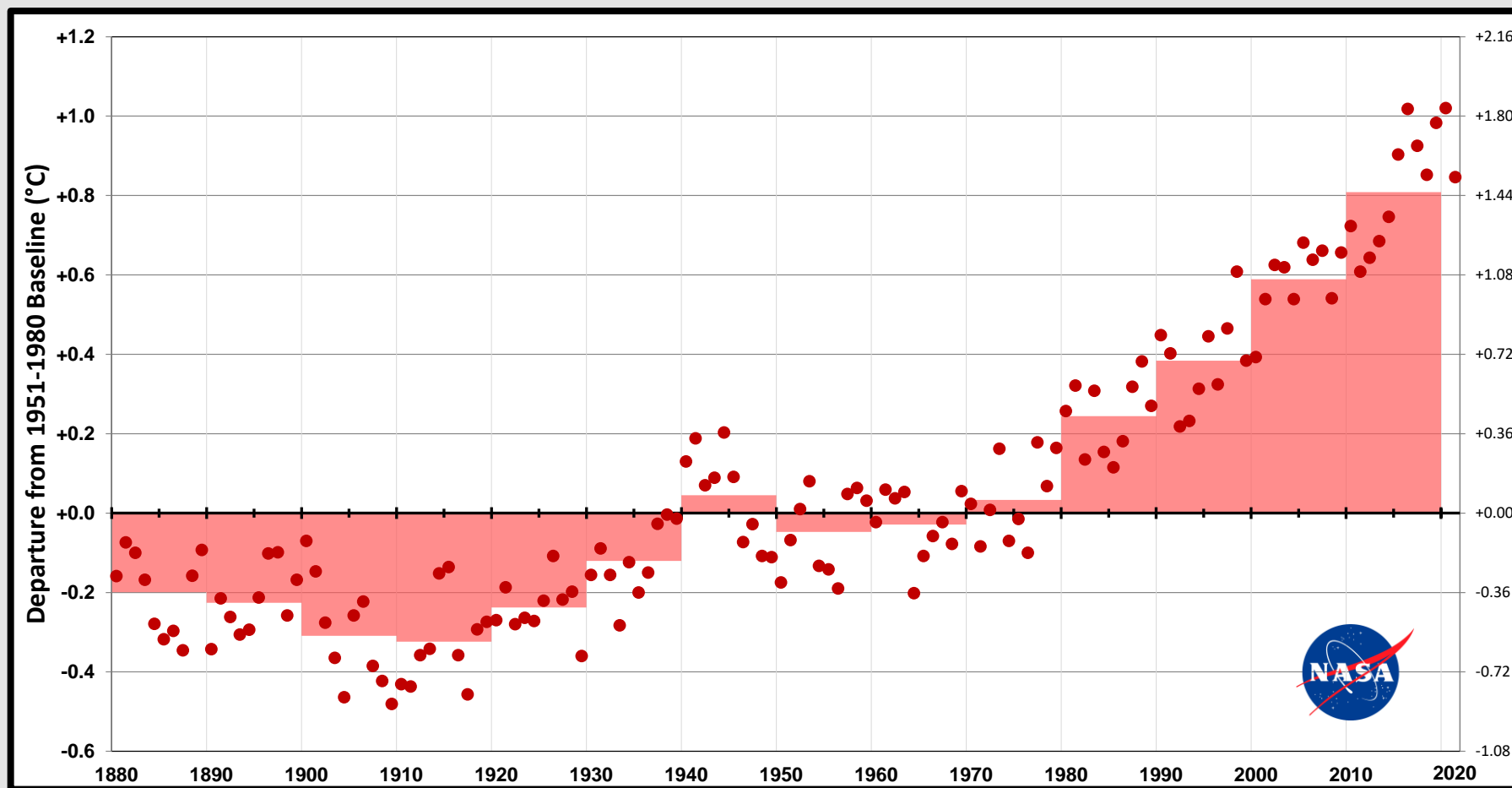


\*NOAA uses 1901-2000 as the baseline in its monthly reports.

For reference purposes, 2021 was 0.81°C (1.46°F) above the 1951-1980 baseline.

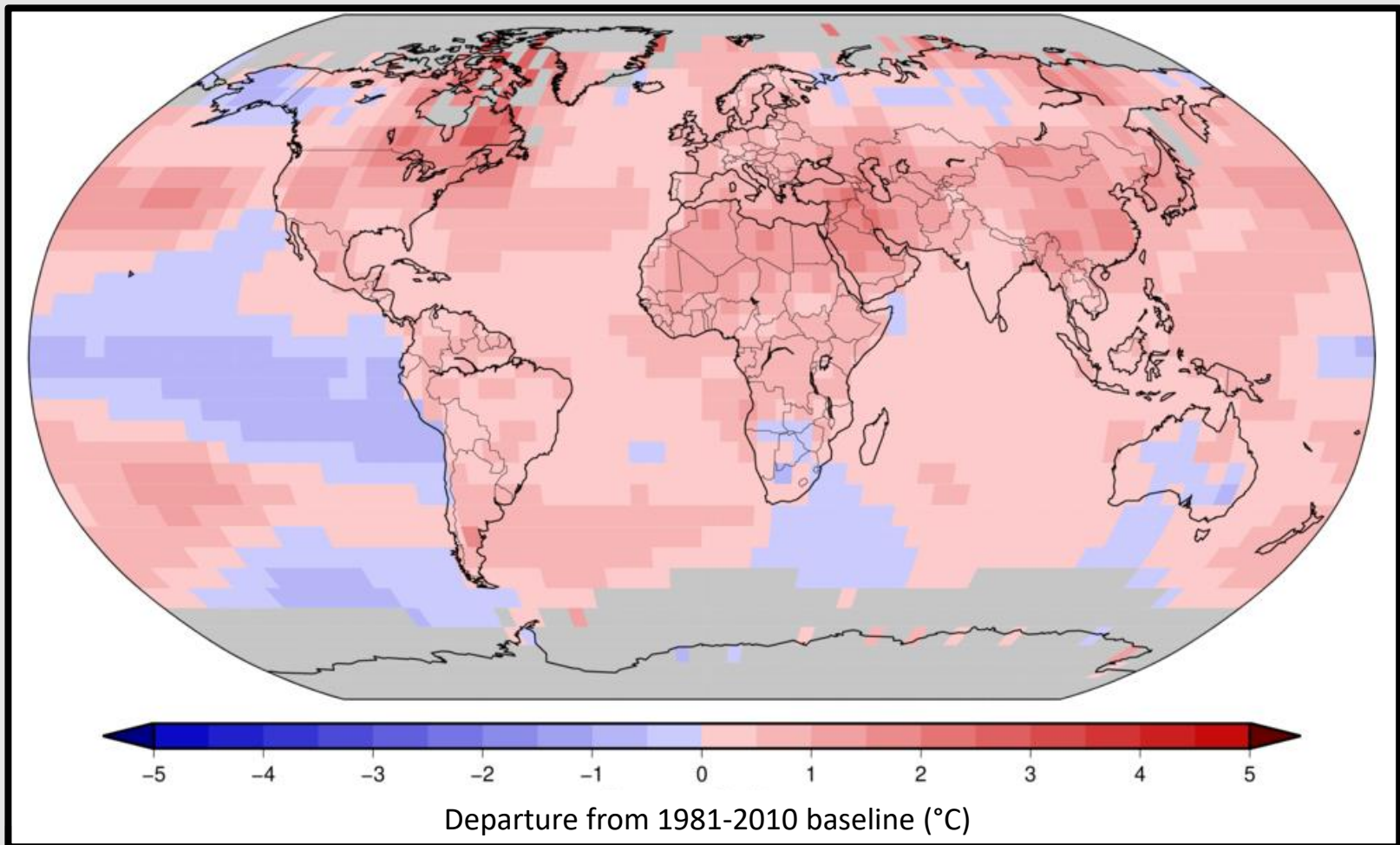
# NASA: 2021 Tied for 6<sup>th</sup> Warmest

0.85°C (1.52°F) above 1951-1980 baseline, statistical tie with 2018



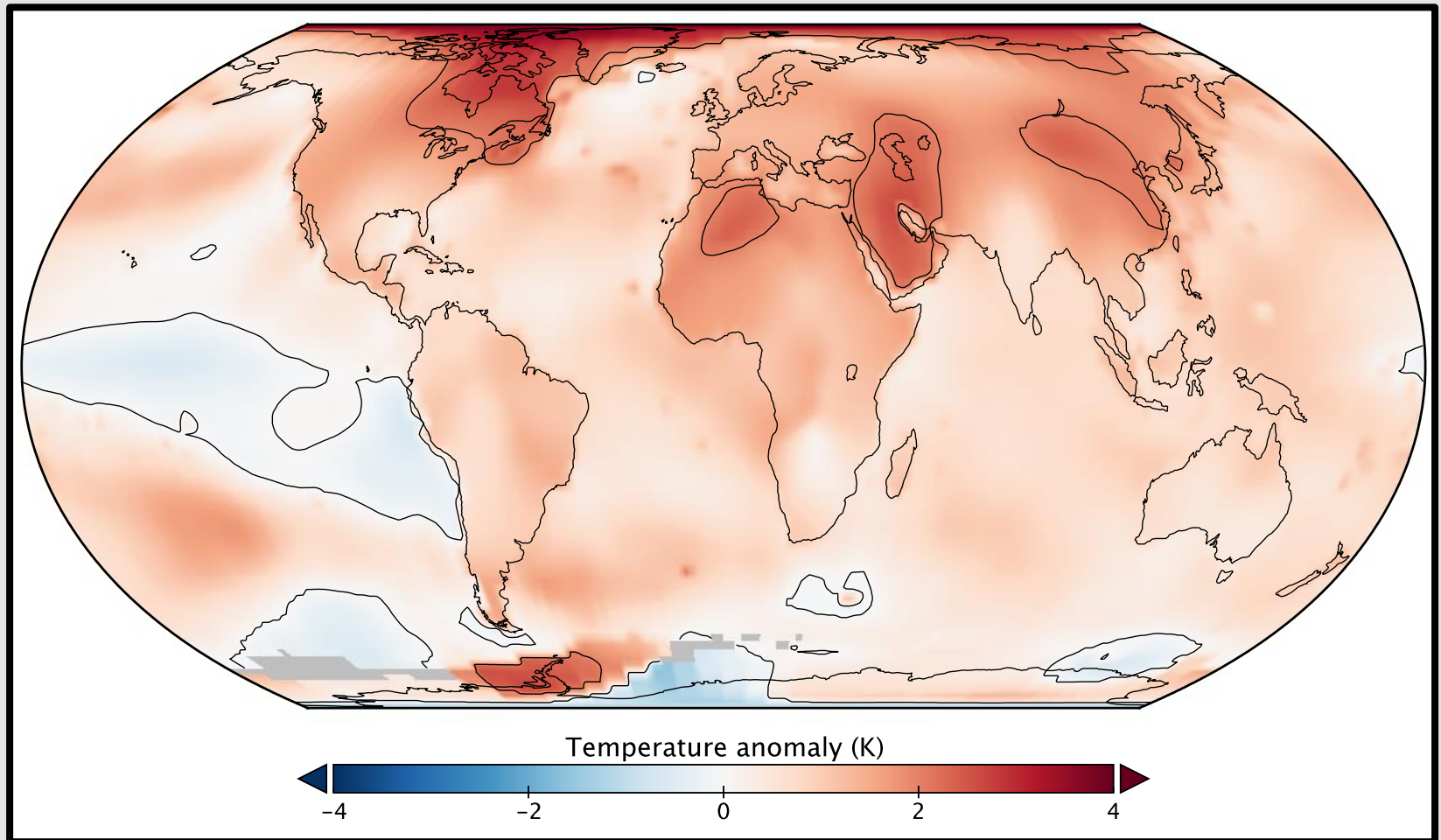
# NOAA: Warm over Land Areas

La Niña in the eastern Pacific slightly cooled global temperatures



# NASA: Warming continues despite La Niña

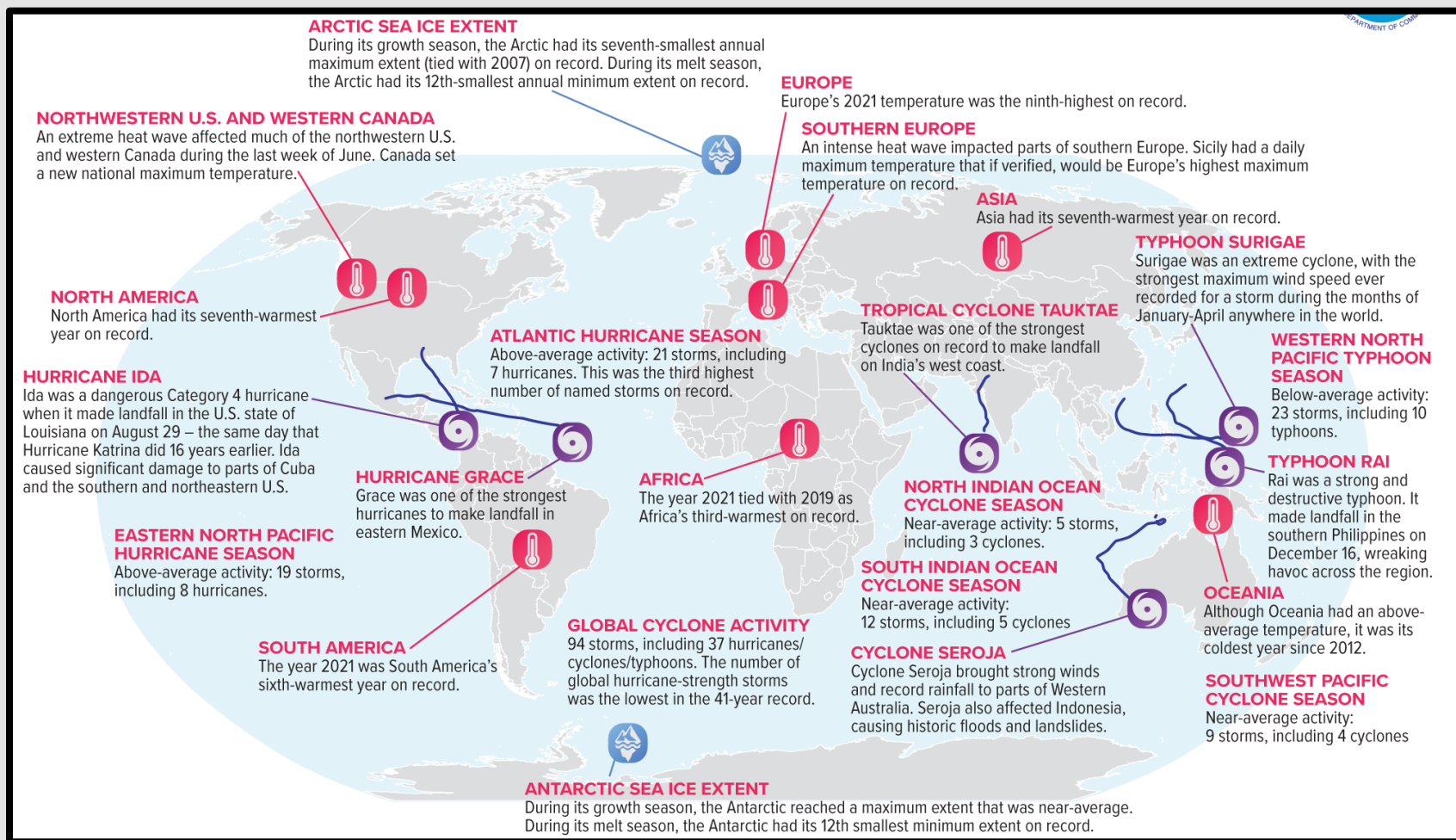
Greatest warming in NH, on land and in Arctic





# NOAA: Significant Events of 2021

## No shortage of extremes



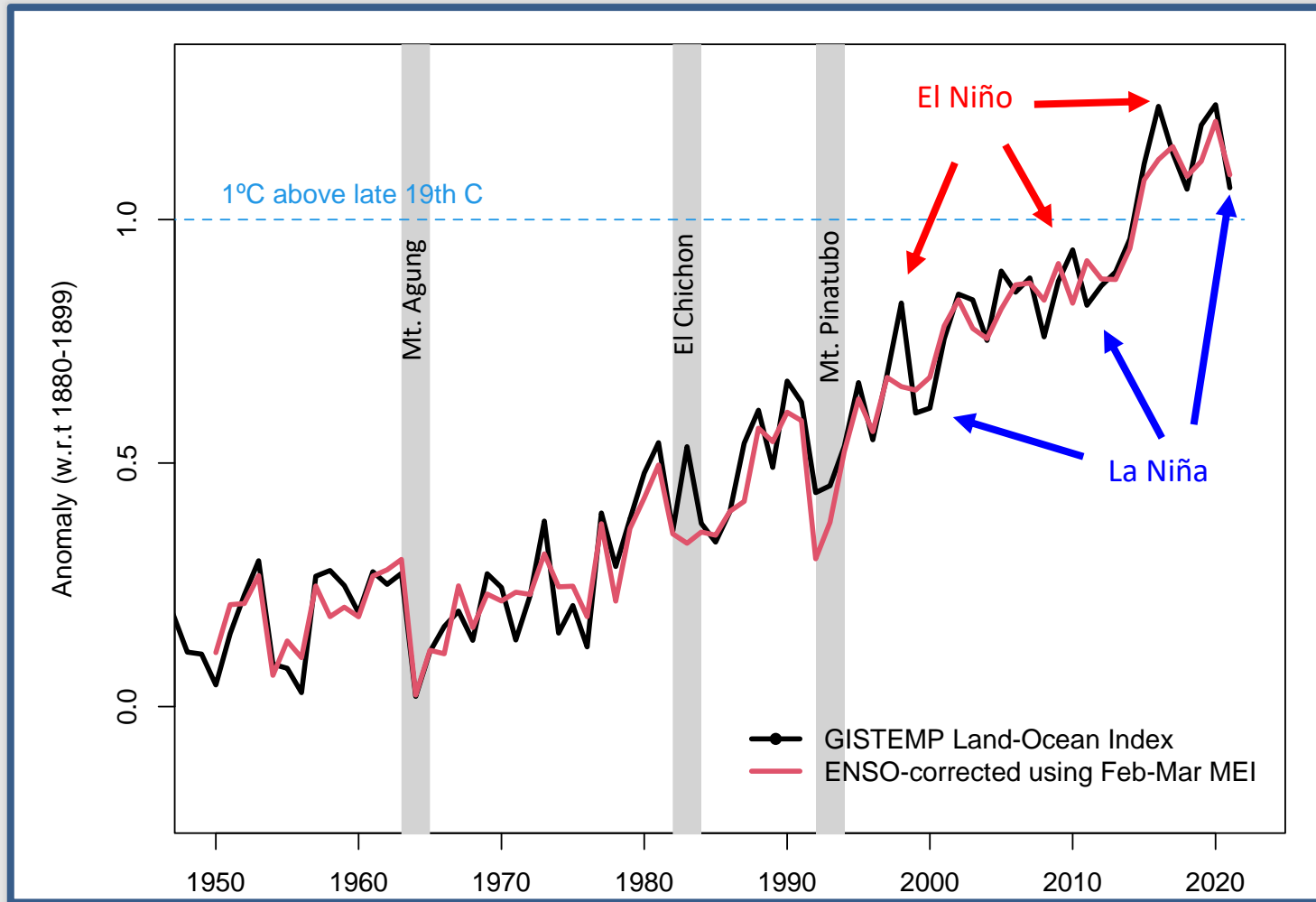
# NASA: ENSO Impacts Global Temperature

Substantial cooling influence from La Niña in the eastern Pacific

## ENSO impact in specific years:

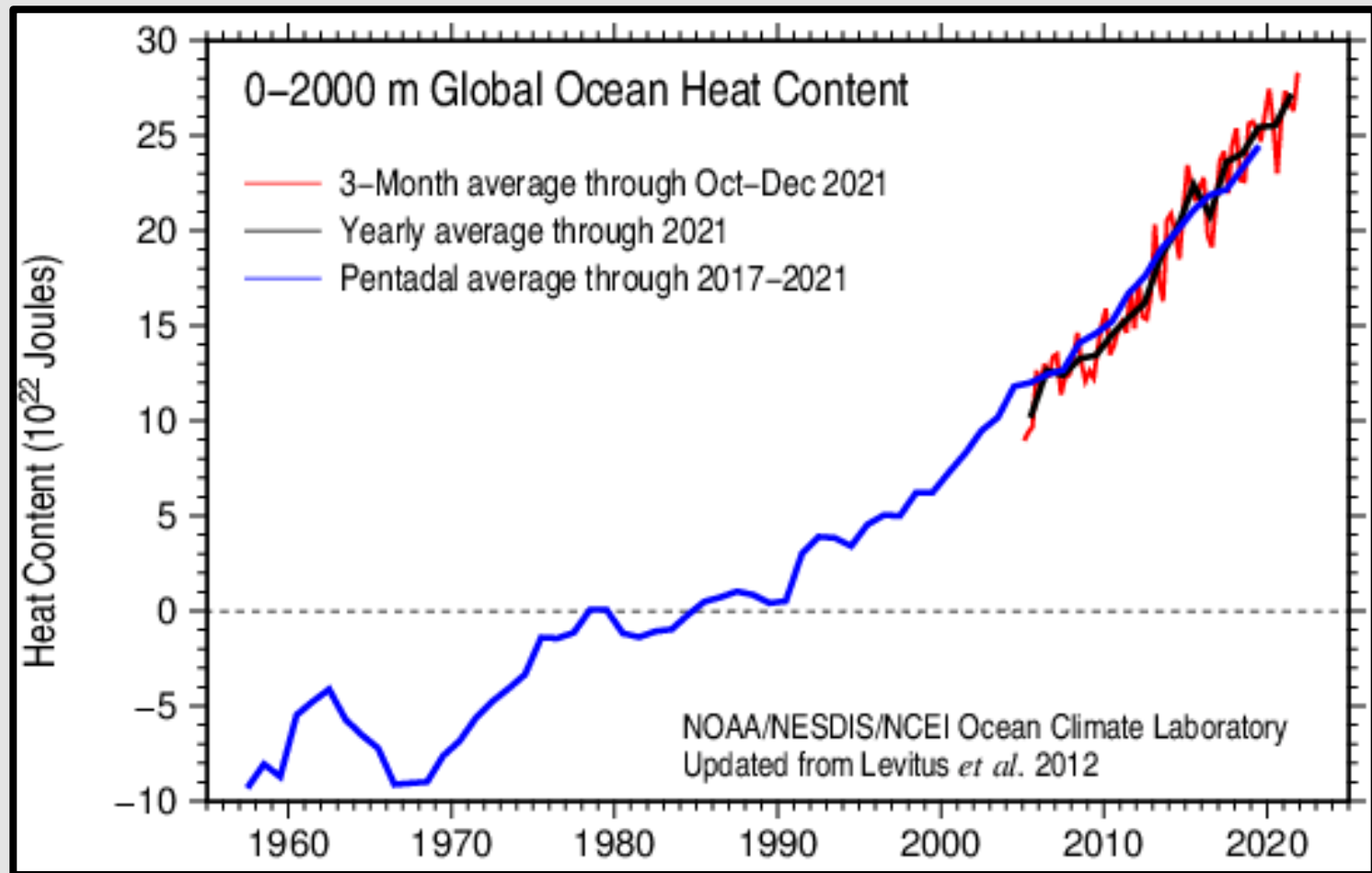
2016: 0.11°C  
2017: -0.01°C  
2018: -0.03°C  
2019: 0.07°C  
2020: 0.03°C  
2021: -0.03°C

(Max. correlation with annual global mean is Feb-Mar ENSO index)



# NOAA: Record High Ocean Heat Content

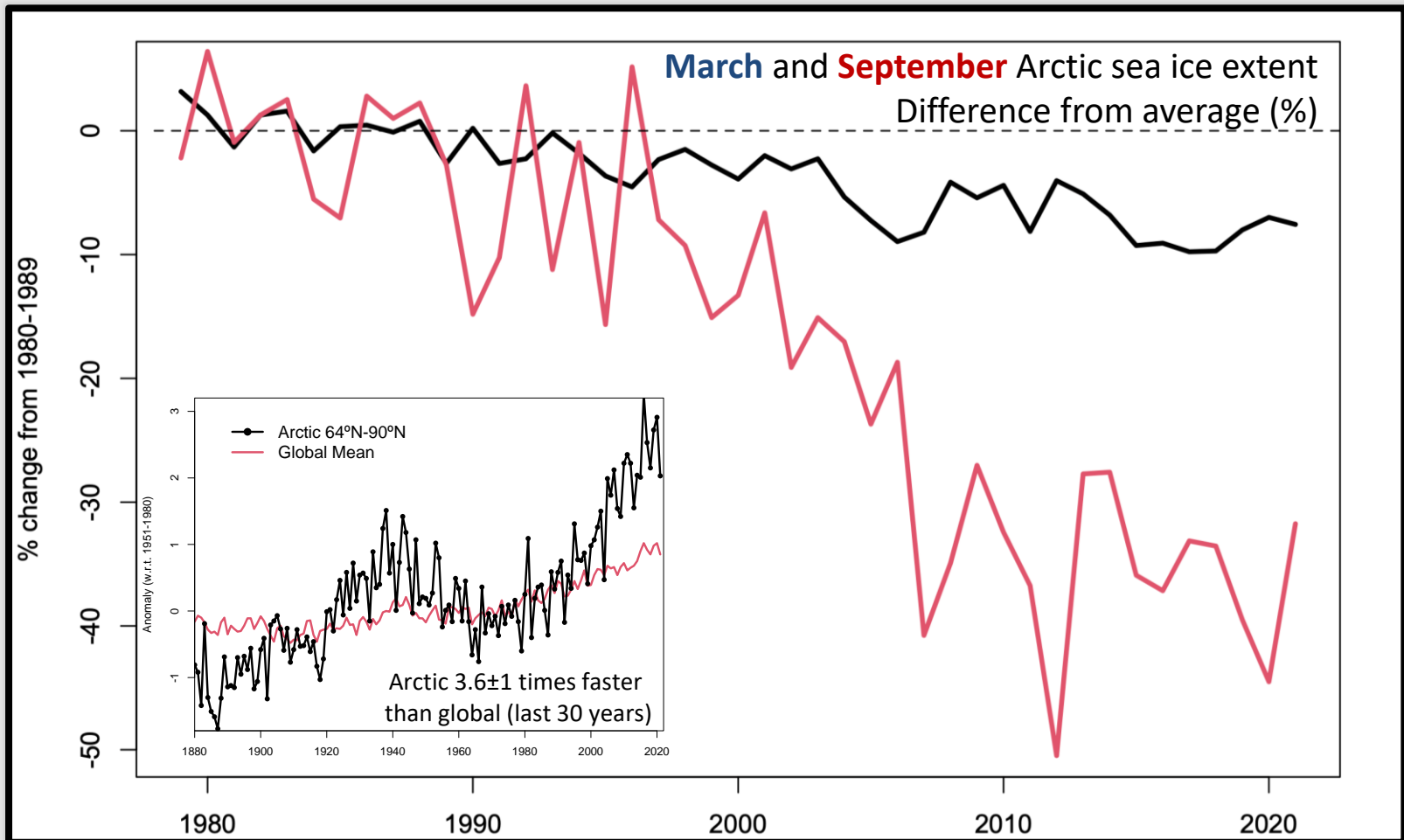
Oceans absorb more than 90% of the excess heat





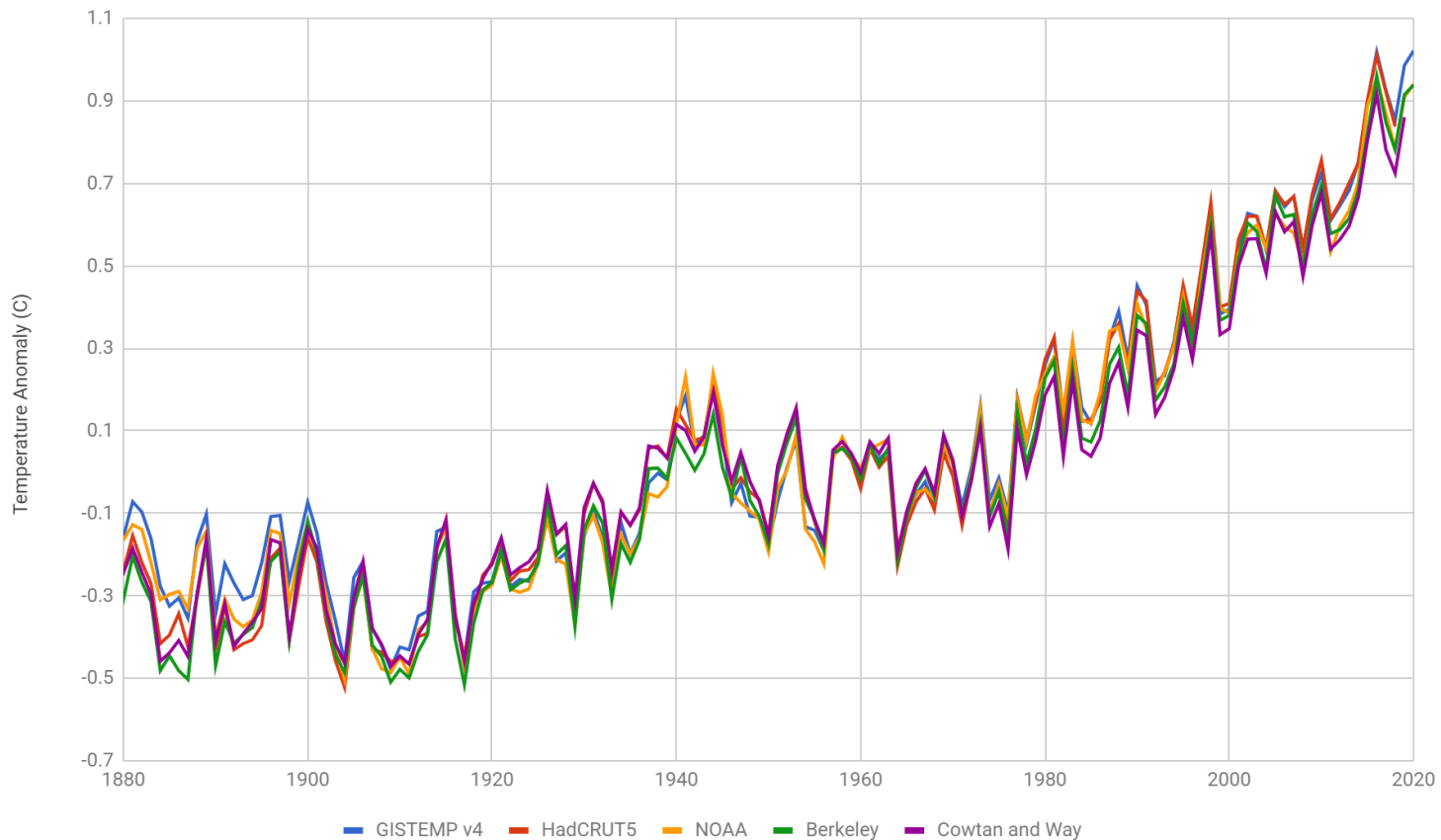
# NASA: Arctic Sea Ice Declines

## Arctic warming more than 3x faster than global mean



# The Analyses Track One Another over Time

## Despite Differences in Methodology and Coverage



# Evaluation Against Reanalysis and Remote Sensing

## Independent data sets validate surface temperature analysis

ERA5 is the latest  
ECMWF reanalysis.

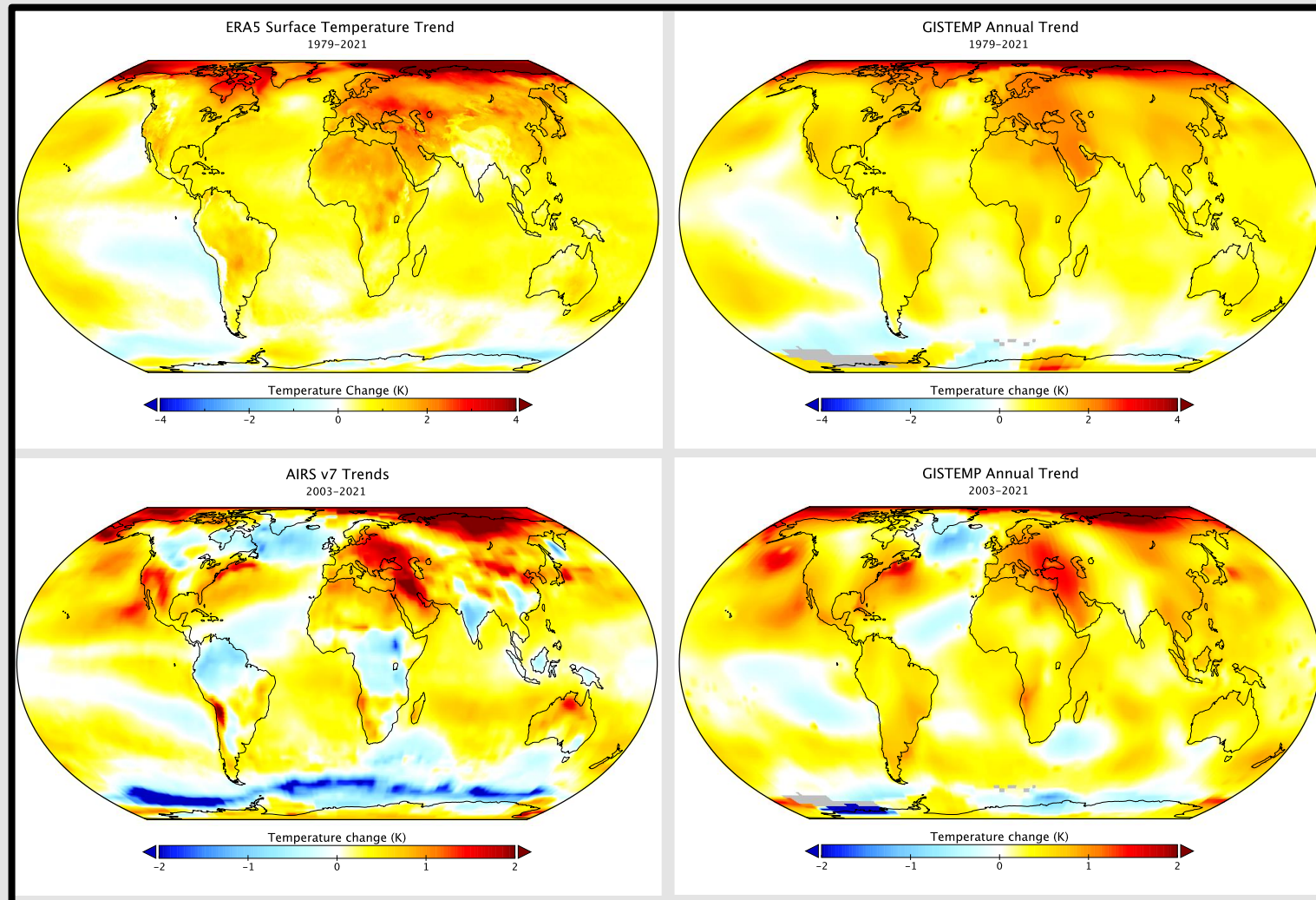
Trends 1979-2021:

ERA5:  $0.82^{\circ}\text{C}$   
GISTEMP:  $0.81^{\circ}\text{C}$   
NOAA:  $0.77^{\circ}\text{C}$

AIRS is an instrument  
on Eos Aqua.

Trends 2003-2021:

AIRSV6:  $0.43 \pm 0.15^{\circ}\text{C}$   
AIRSV7:  $0.30 \pm 0.18^{\circ}\text{C}$   
GISS:  $0.44 \pm 0.15^{\circ}\text{C}$   
NOAA:  $0.44 \pm 0.16^{\circ}\text{C}$   
ERA5:  $0.48 \pm 0.16^{\circ}\text{C}$



# Questions?

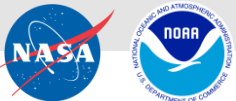
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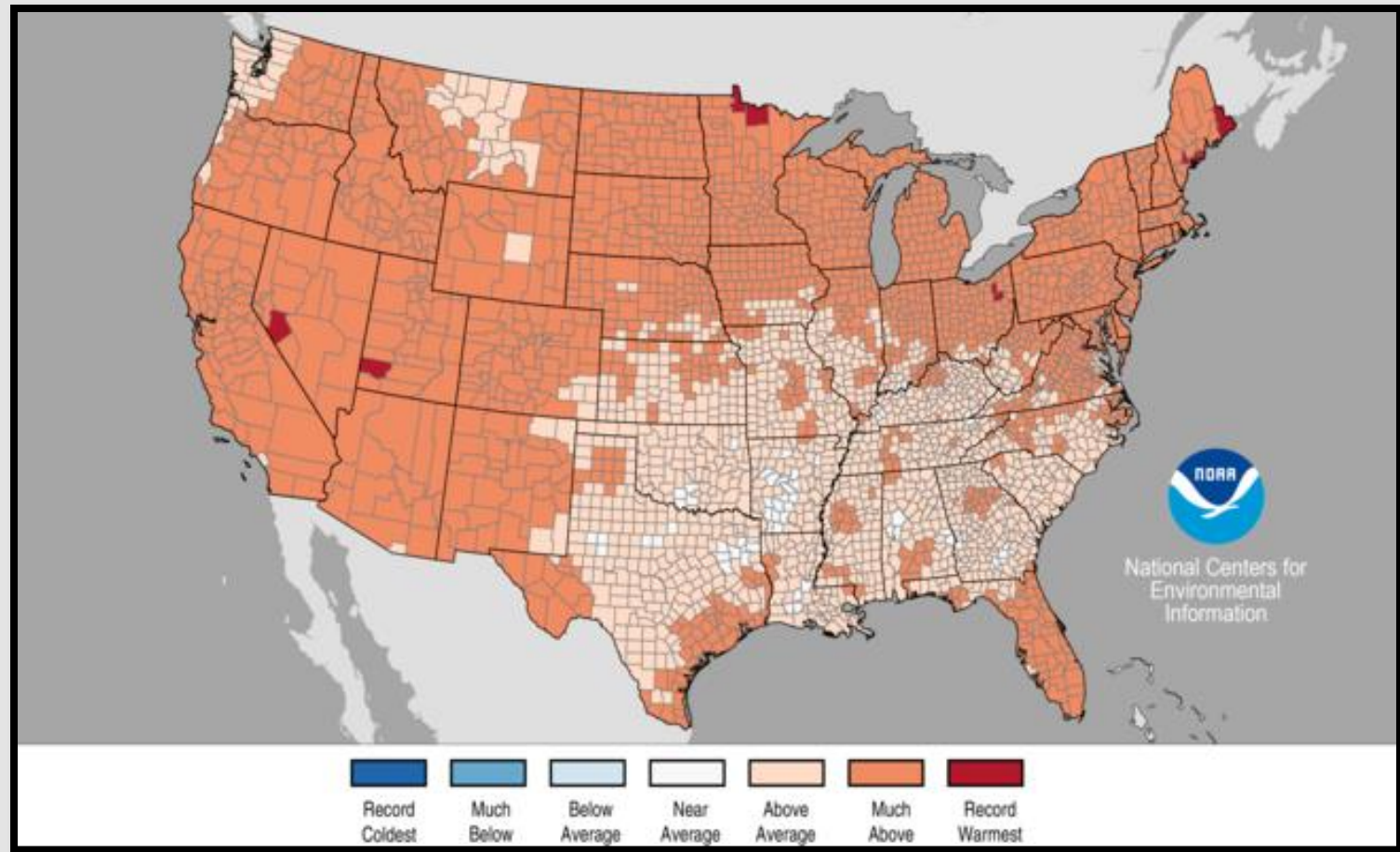
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# 4<sup>th</sup> Warmest Year since 1895

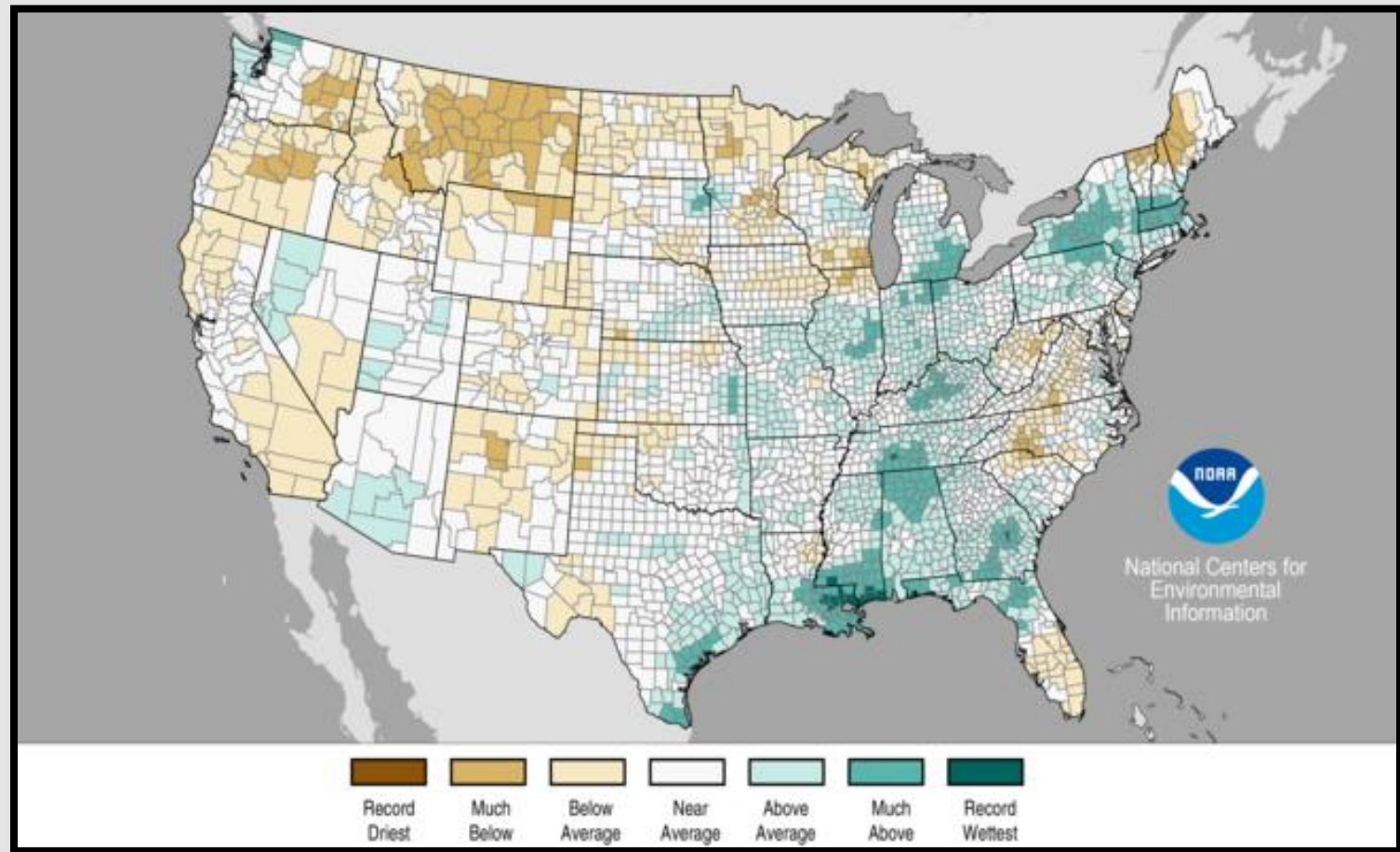
National average: 54.5°F (2.5°F above 20<sup>th</sup> century baseline)





# West Generally Drier than the East

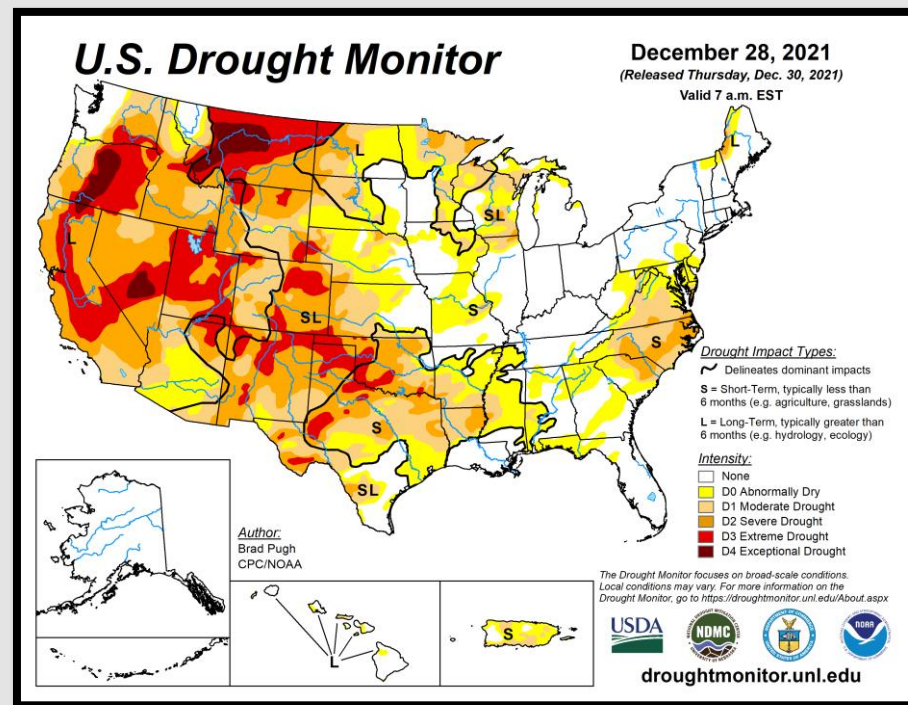
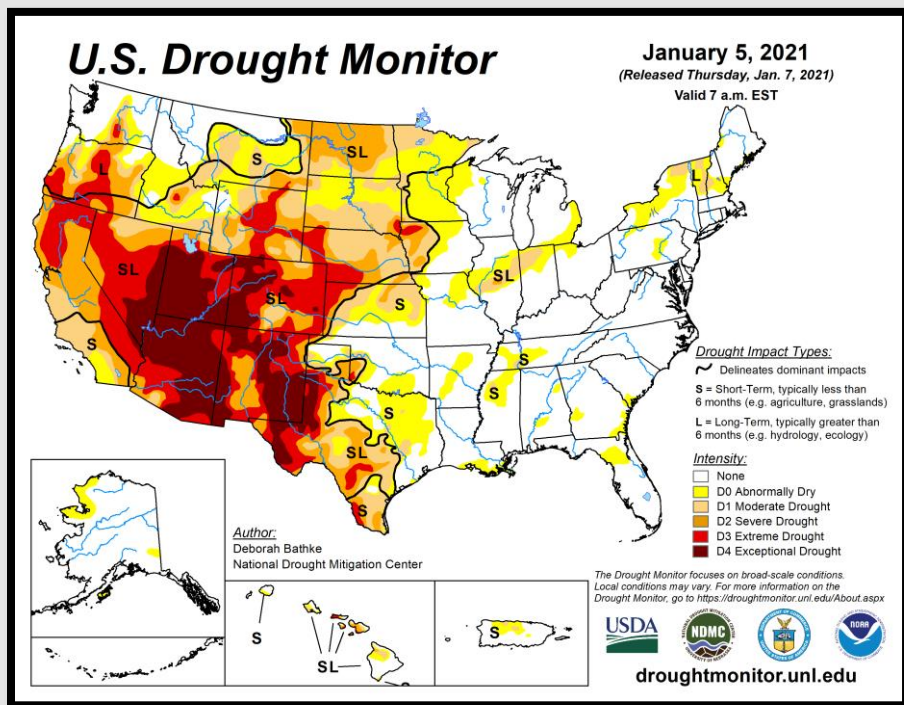
National average: 30.48 inches (0.54 inches above 20<sup>th</sup> century baseline)





# Drought Extent Fairly Steady in 2021

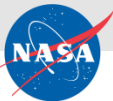
About 60% of U.S. in drought or abnormally dry at end of year



NATIONAL  
INTEGRATED  
DROUGHT  
INFORMATION  
SYSTEM



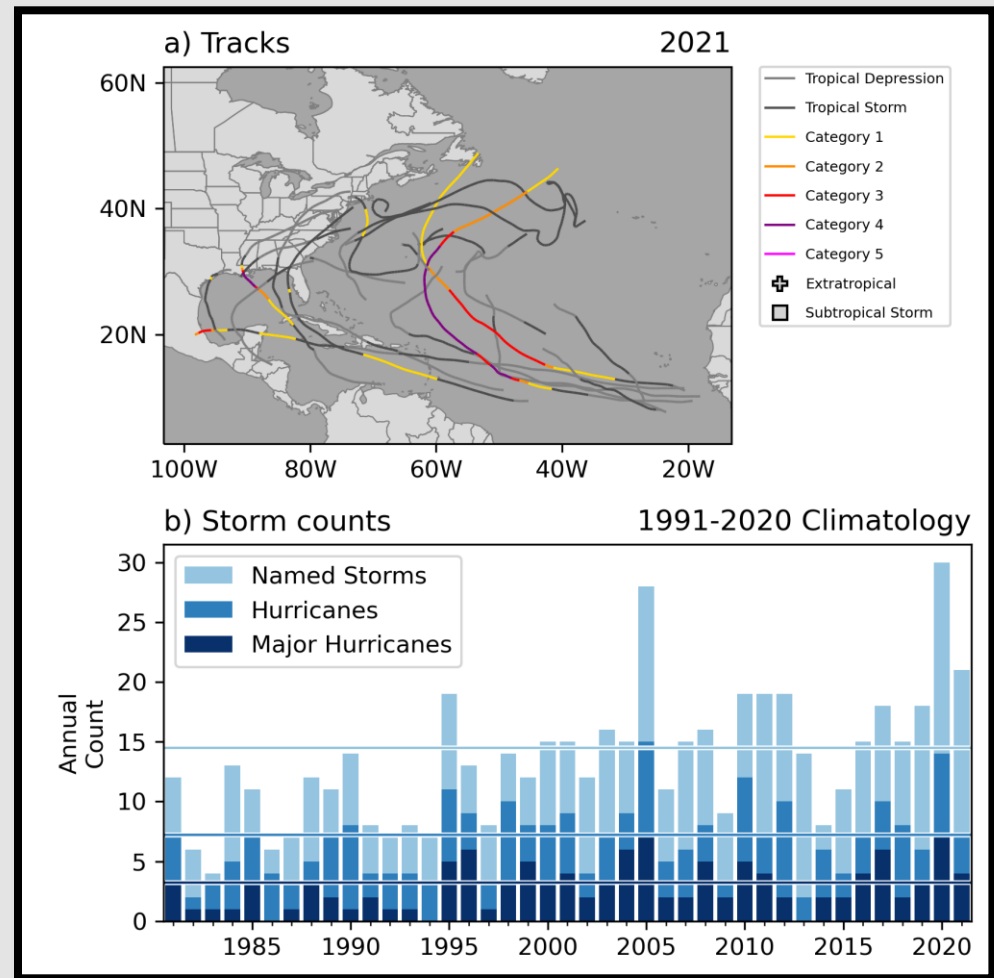
Drought.gov  
U.S. Drought Portal



# Active Atlantic Hurricane Season

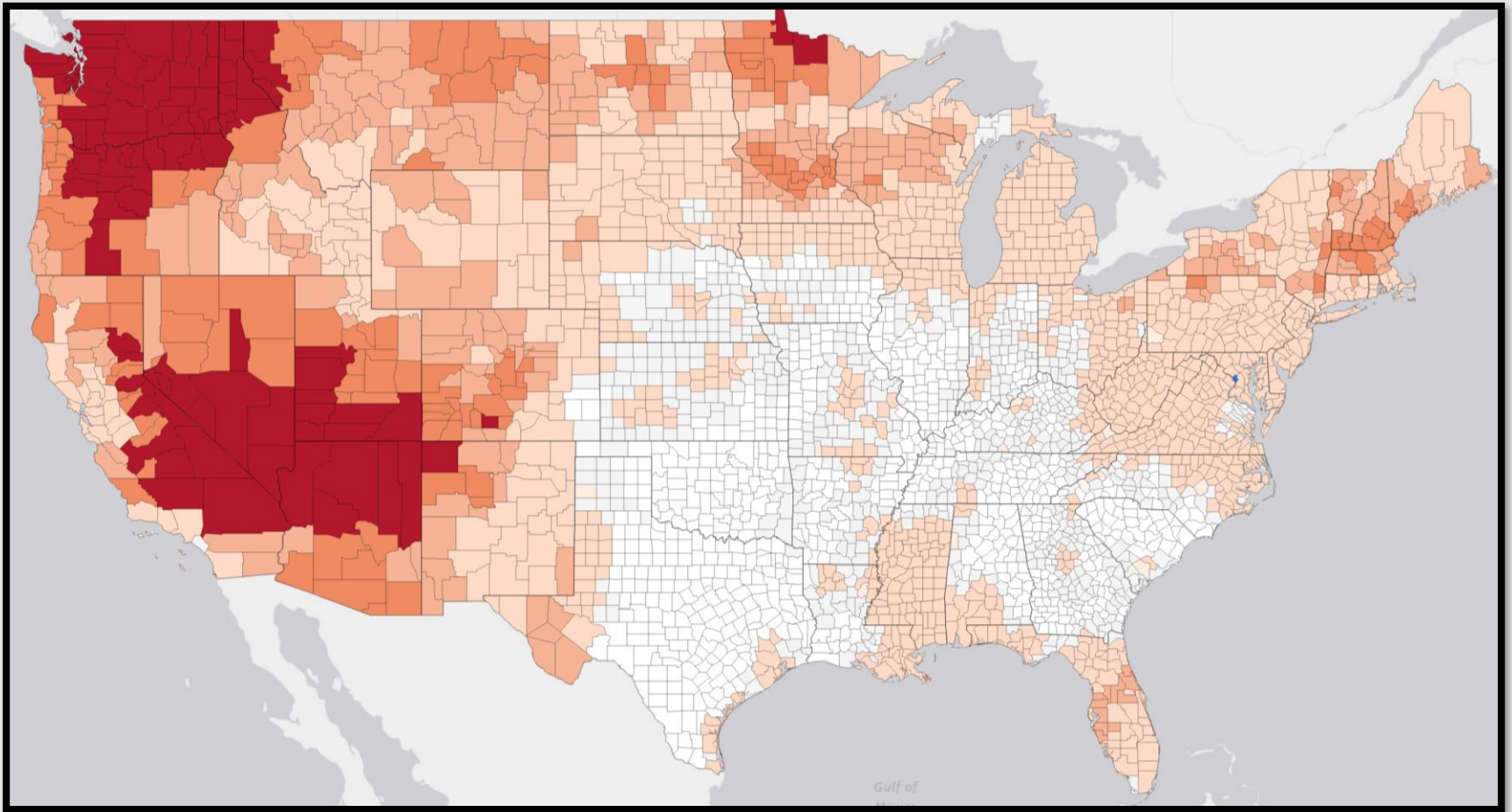
Ida was the strongest landfalling storm and caused the most damage

- 21 named storms (3<sup>rd</sup> highest)
- 7 hurricanes and 4 major hurricanes
- 8 landfalling storms



# Extreme Heat in the West

Numerous counties had their highest 5-day average temperature in 2021





# Another Year of Billion-Dollar Disasters

20 events in 2021 (2<sup>nd</sup> highest), \$145 billion in losses (3<sup>rd</sup> highest)

